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The Value of Mass

In the minds of those charged with the propaganda for the various industries, there seems to be little conception as to the value of mass. Where plastics and light alloys are concerned, the propagandists have taken the myopic view that for every application the lighter its ultimate weight, the better the appeal it makes to the engineer and general public. Actually, for many jobs, weight is essential for efficiency. The plastics industry has announced its intention of manufacturing sewing machines, and so, we are told, no longer will it be necessary for father to carry it from the corner of the spare room to the dining-room table! Yet the utility of such a machine for the hemming of heavy curtains is questionable. Even light-weight typewriters have a habit of wandering. Of more importance is the reduction of weight in machine tools, for here again, going beyond an as yet undefined limit, rigidity is sacrificed. Ironfounders have themselves been inadvertently a little responsible for this craze for lightness, for in recent years they have been asking for evenness of section and a reduction in overall weight as they were in a position to supply a stronger material. It appears to us that, whilst the designer is furnished with the mechanical properties of the materials he incorporates in his machines, as yet he possesses no data as to the requisite mass necessary to assure rigidity in operation. To revert to the sewing machine, a reliable figure of the rigidity required could be obtained by ascertaining the weight of the heaviest fabric, and doubling it, as the pull on the machine is dynamic. The designers, having established the essential weight, might conserve mass and increase portability by making the machine in two parts, the base to be cast iron instead of wood, which incidentally would give increased rigidity, and the upper part mainly in light alloys. Propaganda has been put out by the aluminium interests for cooking stoves to be made in light alloys. Here, again, we feel that the advantages of portability have been overstressed. The cooker will obviously always be housed in the same situation, and the sole advantage of increased portability is the facility it may present for cleaning between the wall and the stove. This applies primarily to electrically heated apparatus, but gas cookers could also be supplied with a flexible pipe connection for this purpose. So far we have heard of no propaganda directed towards the capturing of the lawn-mower trade. The later types carry a different design from the earlier models, as they are apparently self-balancing and only require pushing, but they are down to a minimum weight consonant with efficiency. Propaganda based on lightness would be analogous to trying to sell garden rollers on the same untenable principle.

There are many articles normally made in cast iron or wood which have for years been fabricated in light alloys, purely because of weight considerations as related to the mass of the whole structure. Typical of this activity is the furnishing of submarines, and the aluminium founders would do well to examine their general performance as a basis for civilian exploitation. Generally speaking, the aluminium propagandists have been looking too assiduously at the cast-iron field as being the most promising for cultivation, and too little thought—judging by what has been published—to the competition they will undoubtedly have to meet from plastics. Here "light weight" as a selling point does not exist, and an armoury of alloys equipped with better mechanical properties and/or more pleasing aspect will have to be developed.

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JOINT COUNCIL OF PROFESSIONAL SCIENTISTS

A Joint Council of Professional Scientists, representing over 10,000 qualified scientists, has been set up under the chairmanship of Sir Robert Pickard, F.R.S., by the Institutes of Chemistry and Physics, in association with representatives of professional botanists, geologists, mathematicians and zoologists. The Council has been established to voice the collective opinion of qualified scientists on matters of public interest, to provide a liaison between professional organisations of scientists for co-ordinated action in matters of common interest, and in particular to concern itself with:—(1) The utilisation of scientists to the best advantage in the service of the community; (2) the education, training, supply and employment of scientists; (3) the better understanding of the place of scientists in the community; (4) the maintenance of adequate qualification and ethical standards among professional scientists; and (5) the supply of information and advice to public and other bodies on matters affecting scientists.

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The members of the Council are as follow:—

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The Joint Council has been established for the period of the national emergency, but it may form the nucleus of some more permanent organisation to facilitate the close collaboration between professional men and women practising in all branches of science.

Communications to the Council should be addressed to Dr. H. R. Lang, Hon. Secretary, Joint Council of Professional Scientists, c/o The Institute of Physics, at its temporary address, The University, Reading, Berks.

HAND HOLES FOR COREBOXES

By "Checker"

When a large number of cores is required from a corebox of the frame type it is necessary that the outside should not be damaged by rapping to such an extent that extensive repairs or replacement have to take place before the required number has been produced. To remedy this it is advisable to screw a batten on at each end for rapping purposes, and it is an advantage to have them protruding over the ends of the frames about ¼ in., to give extra protection to the ends. These end battens are, however, often a source of trouble to the coremaker, for when he has turned over the corebox and needs to withdraw

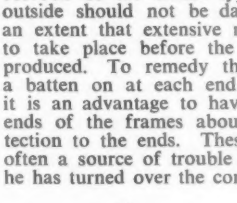

FIG.1.

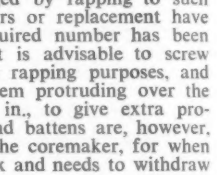

FIG.2.

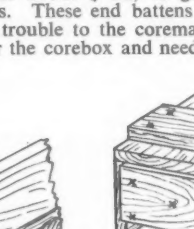

FIG.3.

it from the core, he cannot get a suitable grip. This, however, can be remedied by the patternmaker when making the battens, cutting away part of them for hand holes as shown in Fig. 1, or by making the end battens so that they are at least ½ in. from the top of the frame. This leaves sufficient space to get the fingers under when withdrawing the corebox, as shown in Fig. 2.

When the corebox has been made out of the solid wood, assistance can be given to the coremaker by screwing on two pieces of wood, one at each end, as shown in Fig. 3, for rapping and lifting purposes. If these battens have to be replaced, they can be renewed and returned to the coreshop in a very short time, with little loss to production.

Another Furnace Relining Record

The Gary, Indiana, Works of Carnegie-Illinois Steel Corporation has recently made a new record in relining a blast furnace. Operation of the blast furnace was resumed after a relining time of 21 days, 3 hrs. 50 mins. The relining of the furnace was from the mantle up, and the elapsed time required between the last cast of iron preceding the repair period and the first cast of the new iron production campaign was less than 22 days.

THE PRODUCTION IN ROTARY FURNACES OF STEEL FOR CASTINGS*

By F. A. LEMON, M.I.Mech.E., and HUGH O'NEILL, M.Met., D.Sc. (London Midland & Scottish Railway Co., Derby)

Account of Steel Production at Crewe Loco Works in a Sesci Furnace with Acid Lining

Introduction

It appears that a manufacturer of railway material was the first worker in ferrous metallurgy to make a practical success of rotary furnaces. At the Cincinnati Railway Works, in 1868, S. Danks produced wrought iron for rails in a large coal-fired refractory-lined drum, which rotated about a horizontal axis and rested upon permanent bearings. The basic lining of powdered iron ore and lime was applied as a paste in sections, and afterwards dried and heated. Patches were then melted in turn so as to produce a liquid pool, into which lumps of ore were thrown to chill and solidify the fettling. The present Paper outlines the production of steel at Crewe Locomotive Works in a Sesci furnace something like that of Danks, but operating with an acid lining at temperatures nearly 500 deg. C. higher than his.

The history of the development of rotary puddling furnaces is not without interest, and from Desch's[1] review of the subject we learn that in 1853 Walker and Warren at Dowlais operated ½-cwt. charges in a cylindrical machine which rotated about a horizontal axis. Tooth, in 1859, designed a furnace with a movable flue serving as a door, the lining being of fireclay and not devoid of trouble. Menelaus[2] made many experiments with rotary furnaces and always had trouble with the linings, his first choice of ganister being later replaced by rammed titaniferous iron ore from Norway.

Danks appears practically to have overcome the difficulties of construction and refractory lining, but interest in his undertaking evaporated, owing to the contemporary development of steelmaking by the Bessemer and open-hearth processes. Two rotary puddling furnaces operated in Italy in recent years, and during 1918 research in France was directed to producing pig-iron in a rotary furnace, using pulverised coal as a fuel. Amongst others, the Sesci furnace was thus developed for melting iron for foundry purposes, and during 1932 Messrs. Armstrong Whitworth, at Gateshead-on-Tyne, made steel in a plant of this type installed in their ironfoundry, and similar work was carried out in Germany.[3] About the same time the Mons Steel Foundry in Belgium operated Sesci furnaces entirely for steelmaking,[4] and the Aktiebolaget Bofors in Sweden have used rotary plant extensively for steel production.

Choice of Process

For many years the L.M.S. Railway Company has aimed at the utilisation of the maximum amount of its own scrap in its internal metallurgical processes, and has simultaneously obtained satisfactory results with pulverised-coal-fired installations. For the manufacture of steel castings a Tropenas converter plant and a 12-ton acid open-hearth plant had hitherto been employed, but the claims of the Sesci process as a substitute for these were put before Mr. W. A. Stanier, Chief Mechanical Engineer, by Mr. E. Millington, then Chief Metallurgist. The electric-arc and the open-hearth processes with acid or basic linings were also considered, but the method which normally used the minimum amount of pig-iron appeared particularly attractive. Since it was claimed for the pulverised-coal-fired rotary furnace that the high working temperature available would give very fluid metal, heat from exothermic bath reactions due to the oxidation of pig-iron could be dispensed with. The decision was made about 1932 to instal two Sesci furnaces, the ultimate aim being to develop a melting-down technique analogous to the crucible process. As is well known, this requires neither pig-iron nor a boiling procedure, and generally relies for the production of killed steel on the content of manganese. That the Sesci steelmaking process had hitherto worked only with an acid lining was offset by the circumstance that good railway scrap low in sulphur and phosphorus was available, and it was hoped that, if necessary, a basic lining might ultimately be used. Besides the reduced consumption of pig-iron, the advantage of the rotary-hearth furnace over the Tropenas converter lies in the better control of the steelmaking process and the avoidance of any metal loss by projection. Adjustment of the pulverised-coal distributor and the

FIG. 1.—5-TON NON-REVERSING SESCI FURNACE.

* A Paper prepared for presentation to the Iron and Steel Institute.

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positive air blower should produce either oxidising or reducing flames as required, whilst the temperature and composition control is much more flexible than in the converter. It is a disadvantage that, owing to the absence of side doors, the Sesci bath can be observed only by stopping the flame and sliding back the movable exhaust head, and, above all, the maintenance of the lining presents considerable difficulties.

Description of the Plant

The 5-ton non-reversing furnace made under the Sesci-Garreau patents and illustrated in Fig. 1 consists of a horizontal cylindrical barrel about 10 ft. long and 7 ft. 8 in. in external and 5 ft. 2 in. in internal diameter, terminating at each end in a truncated cone to give an overall external length of about 15 ft. 4 in. It is built of boiler plate with heavy reinforcements. No special provision is made in the steel structure for expansion effects, and the linings must therefore have only slight after-expansion. One end of the furnace is fitted with a mixing chamber and the Sesci coal burner. The exhaust gases escape from the other into a movable head leading by a downcomer to a metallic recuperator of special design. A by-pass is provided so that any proportion of the hot gases can go direct to the chimney, and by this regulation the combustion air is preheated to within limits of 400 to 600 deg. C., as temperatures above 600 deg. C. would cause combustion in the mixer and destroy the grid. The movable head may be displaced in a direction at right angles to the furnace axis, so as to permit of charging and sampling. The barrel is fitted with two cast-iron pathways running on four sets of double rollers, and a 7½-h.p. motor with reduction gear and push button control drives a sprocket chain wound round the barrel, which enables complete rotation of the furnace to be made in both directions, with automatic reversal. Alternatively, a slow rotation in the tapping direction with a fast return or a partial rotation in either direction can be obtained. The original chain drive has been moved to the outlet end of the barrel, as it is cooler in this position. Diametrically opposed tapping spouts are provided at the middle of the barrel.

The fuel supply consists in the first place of a bituminous coal of about 30 per cent. volatile matter content, which from the pulveriser passes to a hopper and a variable output feeder and is thence blown through the mixer. The latter contains a grid and is of wide area and low pressure, the object being to obtain a relatively slow passage of the gases through the furnace. The size of the slots in this grid is important, and $\frac{1}{16}$ in. width has been found desirable. When the recuperated combustion air has reached a temperature approaching 200 deg. C., powdered anthracite is gradually substituted for bituminous coal by the operation of a simple valve. Two pulverisers of the ball mill type are used, and the following specification has been laid down for the powdered fuels:

Bituminous Coal.—85 per cent. minimum to pass through a British Standard 200-mesh sieve.

Anthracite Coal.—99.3 per cent. minimum to pass through a British Standard 120-mesh sieve.

This might be compared with Kittredge's[5] specification when making steel for castings in the basic open-hearth furnace. Using Pennsylvania coal with 58 per cent. of fixed carbon and 4.5-7.9 per cent. of ash he requires that a minimum of 90 per cent. shall pass through a 240-mesh screen. The cost of pulverising and delivering this coal to the furnace is given as $2.03 per ton, and 474 lbs. of coal are used per (short) ton of metallic charge.

Anthracite contains about 10 per cent. of volatile matter with about 0.8 per cent. of sulphur, and has a higher calorific power than bituminous coal. By its use it is claimed that (α) there is less likelihood of

TABLE I.—*Typical Heats.*

	Grade 1 Steel Heat A/14/192.		Grade 2 Steel Heat C/14/35.	
Charge.	Tons.	Cwt.	Tons.	Cwt.
Locomotive tyres		9		9
Carriage tyres		9		9
Wagon tyres		9		9
Laminated springs		9		9
Laminated springs (Si–Mn)		5		5
Heavy mixed scrap		18		9
Gits and runners		9		9
Other scrap		9	1	7
Pig iron		1		1
Tyre turnings		9		...
Spiral springs		9		...
Total weight	4	16	4	16
Approx. carbon content	0·45%		0·40%	

Operation.	Time.	Carbon. %	Time.	Carbon. %
Furnace lit after charging	4.20 P.M.		7.0 A.M.	
First sample	6.25 ,,	0·15	9.0 ,,	0·15
Boil commenced; 3 cwt. of pig and 120 lb. of limestone added	6.27 ,,		9.5 ,,	
Second sample	7.0 ,,	0·175	9.40 ,,	0·20
Third sample	7.30 ,,	0·15	10.25 ,,	0·16
Fourth sample	...		10.50 ,,	0·14
Silico-manganese added	7.36 ,,		10.55 ,,	
Ferro-silicon added	7.39 ,,		...	
Ferro-manganese added	7.42 ,,		10.58 ,,	
Tapped	7.51 ,,		11.7 ,,	
Time of heat, charge to tap	3 hr. 31 min.		4 hr. 7 min.	
Temp. of stream (uncorrected; disappearing-filament pyrometer)	1470° C.		1470° C.	

Composition.	C. %	Si. %	Mn. %	S. %	P. %
Grade 1 heat: Before tapping	0·15	...	...	0·051	0·040
Finished steel	0·18	0·323	0·66	0·058	0·049
Grade 2 heat: Before tapping	0·14	...	...	0·045	0·037
Finished steel	0·19	0·542	1·56	0·046	0·040

Mechanical Tests of Annealed Cast Bars.	Yield Point. Tons per sq. in.	Tensile Strength. Tons per sq. in.	Elongation on 2 in. %	Reduction of Area. %	Izod Value. Ft.lb.	Bend Test.
Grade 1 heat	19·8	30·4	35	55	...	180° U.*
Grade 2 heat	27·4	37·9	26	42	35	...

Temperature.
According to the corrections recommended by the Cambridge Instrument Co. for measuring the temperature of molten steel, a reading of 1470° C. would correspond with a true temperature of about 1600° C. By the courtesy of the British Cast Iron Research Association, temperature measurements were also made with their Bi-Optix instrument, and readings were of the order of 1550° C. The fact that during the repair of the lining the patch is partially fused shows that the temperature reaches 1600° C. approx. The effect of variations in emissivity upon observed optical pyrometer readings has been discussed by Todd (*Metal Treatment*, 1939, vol. 5, p. 171).

* Unbroken.

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contamination of the charge by ash and sulphur, (*b*) the lower content of hydrocarbons gives a low concentration of steam in the combustion chamber, which means reduced oxidation of the charge, and (*c*) the short flame of anthracite gives a more localised heating. On the other hand, the anthracite flame is less luminous than that of bituminous coal, and the authors have considered increasing its luminosity and therefore the radiated heat either by admitting a certain admixture of bituminous material or, alternatively, by injecting oil or lampblack into the burner. The sulphur pick-up during steelmaking amounts to 0.02 per cent. maximum.

For this type of furnace it is claimed that heat radiated from the flame to the charge is reinforced by actual conduction from the hot roof as it passes beneath the slag and bath during rotation. Furthermore, difficulties due to hard taps are avoided, whilst a portion of the metal charge may be removed at any time without emptying the furnace. The whole of the slag cannot be poured off without completely emptying the barrel, but a portion may be removed from the end port.

TABLE II.—*Working Data.*

Ref. No.	Item.	Representative Semi Furnace Data.	Example of Fixed Acid O.H. Furnace.(*)
1	Nominal capacity.	5 tons cast iron; 4 tons steel	25 tons
2	Tapping capacity.	First 4–5 heats, 4 tons; afterwards, 4½ tons of steel	45 tons
3	Average time from first to last tap of week.	84 hr.	126 hr.
4	Output of castings per week.	70 tons, including headers, &c.	341 tons
5	Output of castings per cast.	About 9600 lb. = 4·3 tons	55 tons
6	Time for making frit repair.	90 min. approx.	...
7	Output per hr. including fritting time.*	0·91 tons	2·4 tons
8	Contact reaction area of hearth per ton capacity.	$\frac{67}{4·3}$ = 15·5 sq. ft. approx.	6·65 sq. ft.
9	Output per sq. ft. of hearth area per hr.	20 lb.	19·0 lb.
10	Percentage of slag made.	425 lb. of slag per ton of finished casting = 19%	9·6%
11	Analysis of of slag :	With Lining Material.— † C. / A.	
	SiO_2	59·3% / 62·2%	55·5%
	FeO	11·6% / 13·5%	12·5%
	CaO	5·1% / 9·44%	10·0%
	MnO	13·2% / 12·6%	9·0%
12	Anthracite consumption per ton of castings.	$\frac{2780}{4·3}$ = 645 lb.	700 lb. (bituminous coal)
13	Therms (coal) per ton of castings (from gross calorific power of anthracite).	96	90·7
14	Average fuel analysis and calorific value.	Anthracite.	
		Moisture 1·3%	Producer gas.
		Comb. volatiles 10·9%	CO 20·4%
		Fixed carbon 81·0%	CH_4 2·5%
		Ash 6·8%	H_2 13·4%
		100·0%	
		Sulphur 0·8%	
		Cal. value 14,384 B.Th.U. per lb.	
15	Exit gas analysis and calorific value :		
	Carbon monoxide.	2·67%	
	Carbon dioxide.	15·85%	
	Hydrogen.	0·69%	
	Oxygen.	0·17%	
	Calorific value.	61 B.Th.U. per cu. ft.	
16	Air flow at full load at room temp.	1950 cu. ft. per min.	2180 cu. ft. per min.
17	Temp. of air entering burner.	430° C.	900° C. approx.
18	Charge :		
	Cold pig.	1·5%	40%
	Steel scrap.	98·5%	...
19	Average analysis of charge :		Pig Analysis.
	Carbon.	0·45%	4·0%
	Silicon.	0·40%	2·1%
	Manganese.	0·69%	0·8%
	Sulphur.	0·040%	0·018%
	Phosphorus	0·044%	0·023%
		C lining. 29 lb. / A lining.† 46·5 lb.	
20	Limestone per ton of castings.		32·5 lb.
21	Iron oxide per ton of castings.	Nil	91 lb.
22	Fluorspar per ton of castings.	Nil	...
23	Other additions per ton of castings.	50% Fe–Si 2·2 lb.	
		80% Fe–Mn 6·3 lb.	
		17/73 Si–Mn 24·4 lb.	
		54/39 Alumin 0·46 lb. } to ladle	
		52/60 Ca–Si 1·4 lb. }	
		Aluminium 2·0 lb. to moulds	
24	Bath dimensions (4·3 tons of metal) :		
	Length.	12 ft. overall	28·0 ft.
	Breadth.	3 ft. 10 in.	11·5 ft.
25	Contact reaction area per ton capacity.	15·5 sq. ft.	6·65 sq. ft.
26	Mean bath depth.	10·5 in. (max. 17 in. approx.)	9·35 in.
27	Dimensions of recuperators :		
	Cross-sectional area of :		
	Air uptake.	0·55 sq. ft.	5·0 sq. ft.
	Burner downtake.	1·3 sq. ft.	...
28	Consumption of refractory per ton of castings.	265 lb.	198 lb.
29	Melting loss.	6½%	
30	Weight of original lining material :		
	Barrel.	20 tons A plat (dry), or 22 tons 13 cwt. C lining (wet)	
	plus combustion chamber.	2 tons	
31	Total material for one daily frit.	2 cwt. 3 qr.	
32	Life of lining.	120–130 heats	136 heats

* That is (Tons per week)—(Tonnage of first cast)/(Time from first to last tap).

† See Table VII.

Operation

The charge is introduced horizontally into the furnace from boxes by a standard type of ground charging machine. Up to 13.5 cwts. of turnings may be charged. In some heats a small amount of anthracite is added with the steel scrap, which, together with a little pig-iron, provides carbon to induce a boil. After very many early trials it has been found that to produce a boil and work down the charge in a more or less orthodox way is simpler and produces better steel than to attempt a direct fusion process without boiling. Perhaps the early heats became more oxidised than was desirable, but the interesting thing is that with acid-lined arc furnaces in the United States of America boiling-down is also considered necessary to obtain good castings.[6] In some few cases the authors have made additions of iron ore as an oxidant, but generally there appears to be enough oxidation during melting to promote the boil. Limestone additions are made to the slag after the first carbon sample has been taken.

If the furnace is starting cold, a flow of bituminous coal is introduced into the air pipe, and the air temperature rises quickly to about 180 deg. C. in 10 to 15 min. Gradually the bituminous coal is cut off, and only anthracite will be in use after 30-min. operation. The furnace is given a partial rotation every few minutes to assist in uniform heating, the intention being to melt down as quickly as possible in the hope of keeping the sulphur pick-up as low as possible.[7] Too much rotation at this stage causes the lining to suffer mechanical damage. After about an hour the charge becomes pasty, and the full rotational movement may be applied. A charge of 4½ tons of steel is clear-melted in about 2 hrs., with considerable oxidation of carbon. Boiling soon takes place, and if ore is added, carbon is removed at the rather low rate of about 0.002 per cent. per min. Samples of the metal are taken at intervals and tested by the Carbometer until the carbon has dropped to the required figure. Finishing additions are then made, and the metal can be poured after 3½ to 4 hrs. in the furnace. The taphole is opened and the ladle takes the steel away to

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the foundry. The furnaces are working two or three heats each day for 5 to 5½ days per week, and the details of typical heats given in Table I afford an idea of the present practice.

At the end of each day the lining is examined and a patch is fritted on, if necessary. Average figures for performance are recorded in Table II; the data for a 35-ton fixed furnace reported by the Open-Hearth Committee of the Iron and Steel Industrial Research Council,[8] given alongside, are the only ones available for rough comparison purposes.

Quality of the Steel

Steelmaking in this plant commenced in 1935, and the procedure has been modified from time to time as experience has been gained. At the end of 1935, at th suggestion of Thos. Firth & John Brown, Limited, a 1-ton ingot was made of Sesci steel and examined by that firm. The ingot and slags were analysed (see Table III) and reported upon by them as follows:—

"The only point worth remarking upon is the absence of Fe_2O_3. This is rather remarkable in view of the rather low temperature at which this furnace is operated. It is possible that it is absent because of the reducing action of the coal, but it would need investigating to be sure. At the same time, it has not much practical interest.

"The ingot was sectioned longitudinally, one half being used for macro-examination and the other after forging for physical tests. The latter half was forged to 3 in. square, and the tests were taken from the top of the bottom third of the ingot. Table IV shows the physical test results, which, if anything, are above the average.

"V-segregates are well pronounced and there is some looseness in the centre, but that which is observed is entirely normal and has nothing to do with the method of manufacture. The cleanliness is considered to be above the average.

"Finally, we should like to state that the results show that this process can make this class of steel equal to the best produced in other acid systems."

Analytical results from metal and slag samples taken in February, 1936, are given in Table V.

The authors believe that most steels should be made under conditions of grain-size control. During March, 1936, studies were made of the inherent grain size of the Sesci steel, and from June of that year fine-grained steels have been produced in a general way by controlled aluminium additions. It is known[9 10] that aluminium in steel castings tends to give a sulphide-eutectic type of structure, existing as non-metallic membranes or chains round the crystal boundaries and leading to poor ductility values. On the other hand, Sims and Dahle[11] consider that if, instead of adding

TABLE III.—*Heat C12, September 12, 1935.*

Ingot.		Slags.					
			11.33 A.M.	12.00 noon.	12.45 P.M.	12.58 P.M.	Final from Ladle.
Carbon	0·17%	SiO_2. %	63·30	51·10	59·30	59·30	57·40
Silicon	0·35%	MnO. %	12·02	8·35	6·09	6·12	8·96
Manganese	0·81%	FeO. %	16·42	27·22	23·62	23·62	22·46
Sulphur	0·048%	Fe_2O_3. %	Nil	Nil	Nil	Nil	Nil
Phosphorus	0·042%	Al_2O_3. %	6·00	4·4	4·8	4·6	5·6
		CaO. %	1·60	7·00	4·60	4·80	4·40

TABLE IV.—*Physical Tests on Forged Sample after Normalising.* 0.564 *in.* × 2 *in. Test-piece.*

	Yield Point. Tons per sq. in.	Max. Stress. Tons per sq. in.	Elongation on 2 in. %.	Reduction of Area. %.	Izod Value. Ft.lb.
Longitudinal	22·0	33·2	35·5	61·0	100, 75, 66
Transverse	20·0	33·5	30·0	46·4	30, 35, 42

TABLE V.—*Heat A3/37.*

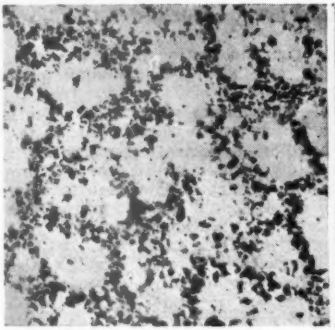
Time.	Metal.			Slag.			
	Carbon. %.	Silicon. %.	Manganese. %.	SiO_2. %.	FeO. %.	MnO. %.	CaO. %.
11.25 A.M. Pig added to bring carbon to 0·3% for boil.							
11.50 ,, Sample . .	0·26	0·110	0·06	65·7	18·1	3·6	8·4
12.5 P.M. ,, . .	0·21	0·049	0·03	62·3	20·5	4·1	8·6
12.20 ,, ,, . .	0·19	0·045	0·03	63·3	18·7	4·1	8·4
12.53 ,, After tapping .	0·22	0·243	0·69	62·3	19·4	4·6	8·7
Examples of tapping samples from a fixed acid furnace.[6]	0·16–0·75	0·25	0·7–0·85	55·5	12·5	9·0	10·0

TABLE VI.—*Examples of Test Results and Specifications.*

Cast No. and Heat Treatment.	Yield Point. Tons per sq. in.	Tensile Strength. Tons per sq. in.	Elongation on 2 in. %.	Reduction of Area. %.	Izod Value. Ft.lb.	Inherent Grain Size (A.S.T.M.).	C. %.	Si. %.	Mn. %.	S. %.	P. %.
A14/197	26·0	36·4	29	55	42	Fine, No. 7	0·20	0·45	1·58	0·030	0·046
B11/54 Standard annealing treatment.	...	36·4	27	39	29	Fine, No. 6	0·20	0·503	1·31	0·045	0·046
B18/39 Standard annealing treatment.	26·2	37·2	28·5	48	33	Fine, No. 7	0·20	0·505	1·51	0·051	0·046
A14/93 Standard annealing treatment.	26·8	39·2	25	43	28	Fine, No. 6–7	0·20	0·357	1·76	0·039	0·044
B/9/53 Standard annealing treatment.	...	39·2	31·5	46	33	Fine, No. 6	0·17	0·14	0·39	0·048	0·044
Cast C14/114. Annealed 900° C., furnace-cooled 4–5 hr. . .	26·4	37·7	27·5	30	21	Coarse, No. 4	0·19	0·56	1·60	0·054	0·047
Annealed 900° C., A.C.	26·6	38·2	19·5	28	27	...	...	...	...	...	...
O.Q. 870° C., T. 650° C. . .	32·4	43·0	23·0	35	23	...	...	...	...	...	...
Specifications. J. O. Arnold's recommendation (anneal and normalise) . .	...	30	20	...	...	...	0·35	0·3	1·0	0·07 max.	0·07 max.
Goodyear tyre moulds (normalise) . .	16	31	15–20	...	...	...	0·22–0·28	0·45–0·5	0·75–0·85	0·03–0·13	0·03–0·03
B.S.S. 24–1930. (c) General railway	...	26 min.	20 min.	...	...	...	...	...	...	0·060 max.	0·060 max.
(b) For wearing surfaces .	...	35–40	15–10	...	...	...	...	...	...	0·060 max.	0·060 max.
U.S.A. wheel centres (Q. and T.)[12] .	34	38	23	...	...	...	0·28–0·35	0·35–0·45	0·65–0·90	About 0·04	About 0·04

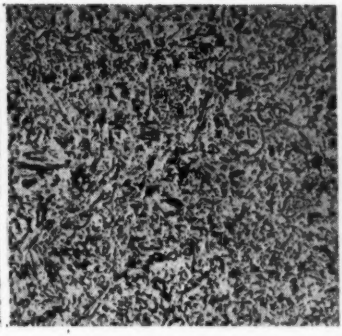
Rotary Furnaces for Steel Castings

the usual ½ to 1 lb. of aluminum per ton, the dose is increased to 3 lbs. or more per ton, then the network formation is hindered, nodular inclusions predominate and ductility is restored. Many United States steel-foundries using acid electric furnaces have confirmed this effect, but others did not find the extra aluminium to be advantageous.[12] Much depends upon the oxygen concentration of the steel when the finishing deoxidisers are added,[13 14] and this means that good slag control must be practised. It is also known that the addition of aluminium makes the steel flow more sluggishly,[15] although aluminium up to 0.05 per cent. "in intricate castings the danger of hot tears is substantially reduced if the sulphur is kept below 0.020 per cent." must be borne in mind. Phillips[17] has reported that tearing is associated with the presence of elongated colonies of inclusions, and that a sufficiency of aluminium causes small globules of Al_2S_3 to form and cracking is reduced. Hot tears have not caused any pronounced trouble with the present steel, but non-metallic inclusions in a boundary-network formation certainly provide the main difficulties in the way of good ductility and bend test values. The present aim is to produce castings containing manganese 1.0 to 1.5 per cent., silicon 0.3 to 0.5 per cent., and aluminium 0.02 per cent.; a typical microstructure after full annealing is shown in Fig. 2. The cellular



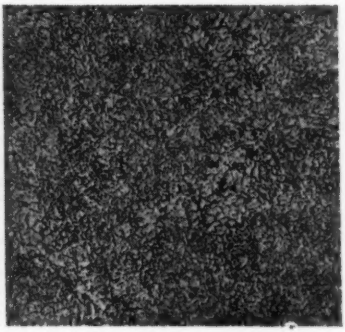
C, 0.20 per cent.; Si, 0.45; Mn, 1.58; S, 0.050; P, 0.046 per cent.
Yield point .. .. 25.0 } tons per sq. in.
Max. stress .. .. 35.4 }
Elongation (2 in.) .. 29 per cent.
Reduction of area .. 55 per cent.
Izod value .. .. 42 ft.-lb.

FIG. 2.—Cast *A*/14/197. Fully annealed 900 deg. C. Inherent grain size No. 7 A.S.T.M., fine. × 120.



C, 0.19 per cent.; Si, 0.51; Mn, 1.44; S, 0.050; P, 0.044 per cent.
Yield point .. .. 25.5 } tons per sq. in.
Max. stress .. .. 39.5 }
Elongation (2 in.) .. 25 per cent.
Reduction of area .. 38 per cent.
Izod value .. .. 20 ft-lb.

FIG. 3.—Cast *D*/16/94. Annealed 880 deg. C., then normalised 860-880 deg. C. Inherent grain size No. 4-5 A.S.T.M. × 120.



C, 0.19 per cent.; Si, 0.51; Mn, 1.44; S, 0.050; P, 0.044 per cent.
Yield point .. .. 24.6 } tons per sq. in.
Max. stress .. .. 35.8 }
Elongation (2 in.) .. 28 per cent.
Reduction of area .. 51 per cent.
Izod value .. .. 35 ft.-lb.

FIG. 4.—Cast *D*/16/94. Annealed, O.Q. 860-880 deg. C., T. 650-670 deg. C. × 120.

(Micrographs reduced to two-thirds linear in reproduction.)

is said to increase the fluidity of red brass.[16] The authors' practice is to work the charge down to a standard condition, as judged in the ordinary way by slag samples, and to introduce some Alsimin (aluminium 54 per cent., silicon 32 per cent., iron 12 per cent.) into the ladle and aluminium wire into the runners of the moulds, the total aluminium addition being about 2 lbs. per ton. The castings contain 0.010 to 0.020 per cent. of aluminium.

Table VI gives some typical results, together with certain specifications, the chief point of interest about the latter being the amount of sulphur and phosphorus which may be tolerated. The authors doubt whether 0.07 per cent. of sulphur is harmful for the details required at Crewe, but the warning of McCance[7] that arrangement of the pearlite shown is presumably due to the slow furnace-cooling permitting too long a time between the upper and lower change points, and a normalised structure such as that in Fig. 3 is probably to be preferred. Ageing of test-bars for eight weeks produces no changes in mechanical properties.

Quenching and tempering treatments are not usually applied, but it may be of interest to mention that one American railway company is reported[18] to have ordered heat-treated carbon instead of annealed alloy steel wheel centres. Some particulars of this proposal are given at the bottom of Table VI, and the structure of one of the present authors' castings after quenching and tempering is shown in Fig. 4.

(*To be continued.*)

FOUNDRY SAND CONTROL

By J. R. DAWSON

One of the most important qualities of sand is its moisture content, because this has a bearing on its strength and permeability. The result of a varying moisture content is similar, whether naturally bonded or synthetic sand is being used. Table I shows the results obtained from tests carried out on a synthetic sand consisting of a Leighton Buzzard silica sand, a naturally bonded sand, 2 per cent. of a proprietary oil bond and 2 per cent. sulphite lye with varying amounts of water.

TABLE I.—*Test Results on Five Sands*

Moisture per cent.	Permeability, No.	Bond, lbs. per sq. inch.	Dry perm. No.	Dry bond, lbs. per sq. inch.
3.0	146	9.1	193	284
4.0	85	7.5	126	498
4.8	253	5.4	105	Over 800
5.4	243	5.7	212	„ „
6.5	61	5.4	126	„ „

This table shows that the green bond decreases but the dry bond increases when the moisture content is increased. The effect on the permeability is rather inconclusive, although in the green state it seems that the airflow is assisted when the grains are covered with only a thin film of moisture, but on increasing the moisture the passage is obstructed and the permeability swiftly falls. From this it would seem that any high dry strength may be obtained by increasing the moisture content, but the snag is that excessive moisture renders the sand difficult to ram, a naturally bonded sand becoming a heavy lumpy clay.

Green Strength.—It is rather unfortunate that high green strength and high permeability do not go hand in hand. To have a high green strength, a sand must have a high clay content and angular or sub-angular grains, and this means a comparatively low permeability. It is possible to compromise to a certain extent with some synthetic sands, but in naturally bonded sands the green strength and permeability reciprocate. A mould or core must be strong enough in its green state to withstand a certain amount of handling, and more intricate jobs need extra strength.

Dry Strength.—The dry strength of a sand is another very important property. It is limited by the facts that a too strong mould will cause the casting to pull, and yet it must be strong enough to withstand any bumps on closing the mould and the flow of molten metals which will wash a weak facing sand into the metal.

Dry strength depends mainly upon the moisture content of the sand in its green state, the shape and size of the grain, the stoving temperature, and the bonding material used. The strongest sands are formed by a silica sand, naturally bonded sand and a synthetic binding material which may be based on a cereal, oil, pitch, or resin, or a colloidal clay such as bentonite. Some of these materials slightly reduce the green strength of the sand, and all reduce the permeability but increase the dry strength.

It is beneficial for all sands to be dried in a stove which is fitted with a thermostatic control, and laboratory ovens should be equipped with a fan to carry off the moisture, and should be capable of keeping the temperature constant to within 2 or 3 deg. C. The most efficient drying temperature differs for different binders. Some oil binders are destroyed about 260 deg. C., but they only oxidise very slowly at 170 deg. C., and the ideal temperature for them is from 220 to 230 deg. C. This is rather high for water soluble binders, however. They should be dried at 170 to 180 deg. C., and so a compromise must be made, and it is usual to dry a mixed lot of test-pieces at 200 deg. C.

Shear Strength.—The shear strength of a sand is about one-quarter to one-half of its dry compression strength.

Tensile Strength.—The tensile strength is approximately one-quarter to one-half of the shear strength.

Permeability.—Another important property of a sand is its permeability, which is that physical property enabling the moulded mass of a sand to allow gas to pass through it. It should not be confused with porosity, which means the pore spaces or voids in a sand and has comparatively little effect on the casting. A sand which is insufficiently permeable will almost certainly cause blow-holes in the casting, because the gases evolved from the molten metal cannot escape. Cores must be especially permeable because the gases have more difficulty in escaping through them. Ganister composition has a low permeability of 15 to 30, in comparison with some core sands which may have permeabilities of 300 or 400, and to enable the gases to escape, vents or "whistlers" are made. This would not be practicable in small moulds, and more permeable sands are used. Any binders, whether clay or synthetic, greatly reduce the permeability of a sand, and care must be taken that in seeking a high dry strength, permeability does not suffer unduly.

Sintering Point.—A sand is useless if it fuses on to a casting. This may be caused by an excessive amount of lime or magnesia, and to guard against using a sand of low refractory value, a test is carried out to find its "sintering point," which is that temperature at which the sand begins to fuse on to the casting. The test is carried out by passing an electric current through a strip of platinum foil which is placed in contact with the test-piece for 4 min. It is then raised. This is repeated with increased current until the strip tends to lift the test-piece, showing that the sand has begun to fuse.

* Extracted from a Paper submitted as an entry in a competition organised for local students by the Middlesborough Branch of the Institute of British Foundrymen.

Foundry Practice No. 57, the house organ of Foundry Services, Limited, Long Acre, Nechells, Birmingham, 7, contains interesting articles on mould and core sands for bronze and high-nickel alloys, and phosphor bronze.

Effect of Minor Alloying Elements on Aluminium Casting Alloys

Most minor alloying elements are beneficial or innocuous to mechanical properties; magnesium and iron require rigid control

(Continued from page 276)

By W. BONSACK

GROUP 3: 4 PER CENT. COPPER-SILICON ALLOYS

This group of alloys actually contains three subgroups in which the silicon content varies in accordance with the mode of casting. Alloys G and GG of Specification B26 have a silicon content of 1.2 per cent. maximum and are sand-casting alloys. Alloy 1-A of Specification B108 contains 2 to 3 per cent. silicon for gravity die casting to increase the castability; alloy 3 of the same specification contains 5 to 6 per cent. silicon for more complicated castings. This same alloy is also used for pressure die casting. This indicates plainly that silicon is a desirable element when fluidity or castability is sought.

Iron in these alloys imparts the same properties as discussed before and need not be repeated. Magnesium and all the other elements act identically in these alloys as in No. 12 type alloy or the 10 per cent. copper alloy.

There is, however, one very interesting comment to make on the sand-cast alloys G and GG. A decided difference exists in the minor alloying elements. Alloy G is of greater purity. Since corrosion resistance is not influenced by relatively small amounts of minor alloying elements when more than 4 per cent. copper is present, the only other objective in holding these elements so low would be to obtain greater ductility. The ductility, however, is greatly influenced by the presence of magnesium; hence, when ductility is required, it would be necessary only to reduce the magnesium content of alloy GG to 0.05 per cent. In either alloy the desired ductility can then be obtained provided the iron content be low enough (1 per cent. max.) to facilitate heat treating. High iron reduces the

TABLE IV.—*Percentage Composition 10 per cent. Cu Mg Alloys.*

Alloy.	Cu	Fe	Si	Mg	Mn	Ni	Zn	Others.	Total hardener.
A ..	9.25	0.2	0.2	0.15	0.03	0.00	0.01	0.05	9.89
B ..	10.75	1.5	1.0	0.35	0.3	0.3	0.4	0.3	14.90
C ..	9.5	1.1	1.6	0.25	0.4	0.35	0.6	0.5	14.3

TABLE V.—*Sand-Cast 4 per cent. Copper Alloy.*

Test No.	Chemical composition, per cent.											
	Cu	Fe	Mg	Mn	Ni	Si	Zn	Pb	Sn	Bi	Cr	Ti
X 250	4.10	0.32	0.01	0.64	0.02	0.70	0.07	0.14	0.14	0.14	0.01	0.02
X 251	3.96	0.88	0.01	0.46	0.05	1.07	0.15	0.10	0.10	0.04	0.03	—
X 265	4.32	1.12	0.04	0.14	0.04	0.70	0.70	0.24	0.12	0.08	0.03	0.03
X 268	4.57	0.92	0.07	0.26	0.14	0.93	0.56	0.10	0.16	0.04	0.03	0 05
X 197	4.21	0.68	0.06	0.43	0.05	0.86	0.39	0.14	0.10	0.07	0.01	—

PHYSICAL PROPERTIES

HEAT TREATMENT: 12 HR. 515 DEG. C., QUENCHED, AGED 1 HR. AT 100 DEG. C.

Test No.	Hardness Rockwell, "E" scale.	Proportional Limit, lbs. per sq. in.	Yield Strength, lbs. per sq. in.	Tensile Strength, lbs. per sq. in.	E. per cent.
X 250	71	12 900	17 400	30 500	5.2
X 251	70	10 500	16 300	30 800	5.4
X 265	66	12 300	18 000	30 500	5.1
X 268	74	16 300	24 000	34 000	4.0
X 197	67	15 000	21 600	33 400	4.5

Effect of Minor Elements on Al Alloys

ductility more than the presence of other elements such as manganese, nickel, zinc, and even lead and tin. It is found in the literature that small additions of silicon, magnesium, nickel, iron, and zinc improve the castability of the alloy, while titanium lowers the

TABLE VI.—*Frequency of Properties of 4 per cent. Copper, 2 per cent. Silicon Alloys.**

Chill cast: Solution heat treated; aged 2 hr. at 212 F.

Tensile strength, lbs. per sq. in.	Frequency, per cent. 1940 Period, 8825 bars	1939 Period, 5462 bars	Average.
33 000 to 34 000 ..	0.0	1.0	0.5
34 000 to 35 000 ..	0.7	2.4	1.5
35 000 to 36 000 ..	6.9	7.4	7.1
36 000 to 37 000 ..	13.4	11.6	12.5
37 000 to 38 000 ..	16.4	13.6	15.0
38 000 to 39 000 ..	17.7	16.9	17.3
39 000 to 40 000 ..	16.2	17.0	16.6
40 000 to 41 000 ..	14.2	13.7	12.5
41 000 to 42 000 ..	9.9	10.9	10.4
42 000 to 43 000 ..	4.5	3.7	4.1
43 000 to 44 000 ..	0.5	1.5	1.0
44 000 to 45 000 ..	0.3	0.3	0.3

Elongation, per cent.	Frequency, per cent. 1940 Period, 8825 bars.	1939 Period, 5462 bars.	Average.
4 to 4.5	0.0	0.3	0.1
4.5 to 5	1.0	3.4	2.2
5 to 6	21.1	25.7	23.4
6 to 7	47.7	46.0	46.6
7 to 8	24.5	20.6	22.5
8 to 9	5.4	3.7	4.6
9 to 10	0.8	0.3	0.5

Chemical analysis of alloys, per cent.

	Cu	Fe	Mg	Mn	Ni	Si
Low	3.9	0.8	0.01	0.2	0.1	1.9
High	4.7	1.1	0.07	0.6	0.5	2.8

	Zn	Sn	Pb	Cr	Bi	Ti
Low	0.1	0.1	0.05	0.01	0.0	0.02
High	0.6	0.2	0.20	0.15	0.1	0.20

* Specification: 33,000 lbs. per sq. in, (14.75 tons) tensile strength; 4.5 per cent. elongation, minimum.

elongation.[6] Both alloys need titanium as a grain refiner, which indicates that they are difficult to use for complicated castings. In other words, common alloying elements which will improve castability cannot be used in alloy G, but titanium can be added to counteract the deficiency in castability. Small amounts of minor elements are very desirable in this alloy: (1) for the reasons given above, and (2) to improve the poor machinability of the alloy. Again it should be recalled that the physical properties are the yardstick for the quality of the alloy, and the chemical specification only a guide for the user.

Table V illustrates the properties found on commercial (secondary) heats of alloy of the type covered by Specifications B26, alloy G. They show that quite satisfactory properties are obtained through a wide variation in composition. It should be noted that the elongation is lower than in the high pure alloys, but the yield strength is appreciably higher.

The gravity die-casting alloy No. 1A of Specifications B108 suffers from the same deficiency of minor alloying elements, as the alloys G and GG above. It has been found in practice that the iron content in this alloy can be considerably higher than in the sand-cast alloys of this type and up to 1.20 does not interfere with the ductility or heat-treatment.[7]

Magnesium interferes with ductility and should not be higher than 0.05 per cent. where more than 4 per cent. elongation is desired. Manganese can be used up to 0.7 per cent.; nickel up to 0.5 per cent.; zinc up to 1.2 per cent. Lead, tin, cadmium, bismuth, chromium, and titanium have the same influence as mentioned before and should be used for good machinability.

Table VI gives an interesting résumé of the statements made for alloy 1A (Cu 4.5; Fe 1.0; Si 2.5; Mg 0.05; Mn 0.3; and Zn 0.2 per cent.) (Specifications B108). For two years tests have been conducted on every heat of metal made. More than 14,000 bars were tested and the properties and analyses statistically recorded. The table gives the frequency of tensile strength and elongation as they were found in 1939 and 1940, and also the average for the two-year period. The majority of alloys tested between 16.1 and 18.7 tons per sq. in. tensile strength and 5 and 8 per cent. elongation. The chemical analysis during these two years varied between the limits given in the table. It also should be mentioned that all these heats were accepted by our Armed Forces and used for war production.

The alloy 3 (as 1A, but Si 5.5; Mg 0.1; and Zn 0.5 per cent.) of Specifications B108 is used for complicated castings of which relatively low properties are required. It should not be compared with the alloys above as far as ductility is concerned. However, the influence of the minor alloying elements is the same on this alloy, and they should be used to the same advantage. The properties of this alloy could be improved considerably by heat-treatment.

GROUP 4

The same alloy No. 3 is found as No. VII of Specifications B85 as a pressure die-casting alloy. How-

Effect of Minor Elements on Al Alloys

ever, the composition as far as minor elements are concerned is much different. The iron content is more than twice as high as in the gravity die-casting alloy and undoubtedly too high to give maximum properties. This limit of 2.3 per cent. was set to accommodate the die-caster of olden times, who had difficulties in preventing iron pick-up from the die-casting machines. However, in modern machines of the cold-chamber type, the aluminium does not pick up much iron, and it should be possible to reduce the iron content and thus improve the ductility of the alloy.* Magnesium is high enough to cause age-hardening at room temperature; it should by no means exceed 0.1 per cent.

Influence of Mn, Si and Ni

Manganese is considered quite beneficial in die-casting alloys, since it is said to prevent the sticking of the casting to the die. Furthermore, it reduces hot shortness and modifies the effect of high iron. Therefore, it is a very desirable element for the die-caster and its content in this alloy should be increased to 0.6 per cent.[2 5] It is again interesting to note that zinc is tolerated up to 1 per cent. in die-castings, although it is said to cause hot shortness in sand and gravity die-castings when used in excess of 0.2 or 0.4 per cent.

Tin is also permissible in pressure die-casting alloys, while it is said to cause hot shortness in other modes of castings. Nickel is permissible up to 0.5 per cent. If it does no harm in the pressure die-casting alloy, it should also be harmless or equally beneficial in the sand and gravity die-casting alloys of this type.

In alloy IX (Cu 3.5 to 4.5; Fe 1.8; Si 1 to 2.5; Mg 0.05; Mn 0.3; Zn 0.8; Ni 3.5 to 4.5; and Sn 0.1 per cent.) of Specifications B85 the silicon content is decreased to about 2 per cent. and the nickel increased to about 4 per cent. This is, of course, a different alloy and cannot be directly compared with the alloy VII (Cu 3.5 to 4.5; Fe 2.3; Si 4.5 to 5.5; Mg 0.1; Mn 0.3; Zn 1.0; Ni 0.5; and Sn 0.1 per cent.). However, it has nearly the same physical properties. The iron content is somewhat lower, but manganese is still 0.3 per cent. maximum as in most other alloys, although higher amounts are beneficial for the above reasons. The two alloys are practically obsolete and specifications have not been modernised, but they are still carried in the specifications.

The most interesting part of alloy IX of Specifications B85 is the high nickel content. While thus far nickel has been treated as an undesirable impurity, in this alloy it is considered a desirable alloying element. This alloy has nearly the same physical properties as alloy VII. It is further interesting to note that the only difference between the two alloys is the replacement of 3 per cent. of silicon in alloy VII by 3 per cent. nickel in alloy IX. Both have nearly the same properties. This seems to imply that 1 per cent. of silicon is equivalent to 1 per cent. of nickel in copper-aluminium alloys. In alloy VIII (Cu 1 to 2; Fe 2.0; Si 0.5 to 1.0; Mg 0.1; Mn 0.3; Zn 0.5; Ni 1.75 to 2.5; and Sn 0.1 per cent.) the copper is much lower than in the previous alloys. The silicon content is also down to near 1 per cent., and the nickel content is reduced to about 2 per cent. This alloy exhibits greater ductility than most of the other pressure die-casting alloys. The iron content is higher than in alloy IX, and the magnesium content also is higher, reducing the ductility of the alloy to some extent. Manganese as usual is 0.3 per cent. The zinc content, however, has been reduced to 0.5 per cent. It is hardly reasonable to suppose that in this alloy, which has basically the same composition as the two previously mentioned alloys, more than 0.5 per cent. zinc should be harmful. Since zinc is a very mild hardener and is also desirable as far as castability is concerned, the zinc limit could be increased to 1 per cent.

Y Alloy

The next two alloys, alloys H and 11, the sand-cast specification and the gravity die-casting specification, constitute an old alloy generally known as Y-alloy. In both alloys the chemical specifications are identical. The physical specifications differ slightly. The sand-casting alloy requires a minimum of 14.3 tons per sq. in., while for the gravity die-casting a minimum of 14.7 tons per sq. in. tensile strength is required under heat-treatment No. 1. The three main alloying constituents of the alloy are copper, magnesium and nickel. Copper is within the limits of 3.5 to 4.5 per cent., as in many of the previous alloys. Nickel is limited to 1.7 to 2.3 per cent., and the interesting element in this alloy, magnesium, from 1.2 to 1.8 per cent. This is the first alloy so far considered in which magnesium is desired in amounts above 1 per cent., and the subject has thus gone through three stages:—(1) Magnesium as an undesirable impurity; (2) as a desirable element in small amounts; and (3) as a desirable element in higher amounts. Magnesium has a high affinity for silicon and forms the hardening compound, magnesium silicide. It is, therefore, necessary to limit the silicon to low amounts. and in this case 0.7 per cent. is the maximum allowable.[8] If higher amounts are present, the hardness is so great that the alloy becomes nearly brittle.

The nickel content imparts to this alloy its resistance to softening at elevated temperature.[4 9] This alloy has been used for many years for cylinder heads and pistons where relatively high temperatures prevail. The manganese content is again limited to 0.3 per cent., as in most of the other alloys thus far, and there seems to be no basis for this limitation. It has been found by experience that nickel and manganese can be partly substituted for each other, and if higher manganese is found in the alloy, not as much nickel is necessary to get the same results. At this time the supply of manganese seems to be less critical than nickel. Hence, it would be of advantage to use manganese partially to replace nickel in such alloys as Y

* This has been recognised lately and new specifications have been approved in which the iron content has been reduced in castings made on the gooseneck machines to 2.0 per cent., and on cold chamber machines to 1.3 per cent. These alloys are now known as VIIA and VIIB, respectively.

Effect of Minor Elements on Al Alloys

(H and 11). Even with nickel at the top limit of the specification, the higher manganese content may be desirable. Zinc has been limited in these alloys to an extraordinary extent. The earlier specifications for these alloys limited zinc to 0.01 per cent. Later this specification was "relaxed" and 0.03 was allowed. Within the past year or so the zinc limit was increased to 0.1 per cent. This low limit was supposed to prevent hot shortness in the alloy. This supposition, of course, is wrong, since it has been found definitely that zinc does not cause hot shortness. Tests made by the author on these alloys indicate that zinc content as high as 3 per cent. does not decrease the strength at elevated temperature. In fact, it increases the strength at room temperature and the alloy maintains its

TABLE VII.—*Influence of Zn on Y Alloy.*

Cu, per cent.	Fe, per cent.	Mg, per cent.	Si, per cent.	Ni, per cent.
4.10	0.39	1.63	0.23	1.83

Zinc, per cent.	Tensile strength, lbs. per sq. in.			Brinell hardness.		
	Room temperature.	150 deg. C.	225 deg. C.	Room temperature.	150 deg. C.	225 deg. C.
0.03	32 200	31 100	30 000	91	89	90
0.22	34 800	34 300	31 200	92	93	93
0.42	35 500	33 500	31 800	93	95	95
0.66	36 100	34 200	32 900	97	95	98
0.76	36 500	35 000	33 000	99	100	99
1.34	37 800	36 100	34 000	101	100	99

strength at elevated temperatures, as shown in Table VII.

Zinc was added to the alloy in steps of 0.2 per cent. up to 1.3 per cent., and an increase in tensile strength was noted. Also an increase in hardness can be observed. With this increase in tensile strength and hardness, the hot shortness as measured in a gravity die-casting was reduced from 20 per cent. on the zinc-free alloy to 8.5 per cent. on an alloy containing 1.3 per cent. zinc. It will be seen in the table that the alloy containing 1.3 per cent. zinc has a tensile strength of 16.9 tons per sq. in. at room temperature, and at 150 deg. C. the alloy has a tensile strength of 16.1 tons per sq. in. At 225 deg. C. the strength is 15.2 tons per sq. in. The alloy without zinc never reaches such a high tensile strength at room temperature. At 225 deg. C., the alloy containing 1.3 zinc is 10 per cent. stronger than the alloy containing no zinc.

A heat treatment, corresponding to heat treatment No. 2, and also a treatment A to produce greater ductility, was given in these alloys. These tests gave properties as shown in Table VIII.

These tests demonstrate conclusively that zinc is a desirable addition to this alloy—it increases the tensile strength and hardness without reducing the elongation. The increase in tensile strength in this alloy by addition of zinc is remarkably high. It can be increased as much as 20 per cent. by adding 1.5 per cent. zinc, without reducing the ductility of the alloy noticeably.

The other elements in the alloy of this specification are kept to 0.3 per cent. These other elements include lead, tin, and titanium, which are frequently added to improve the machinability of the alloy. A higher percentage, such as 0.5 or 0.6, of these elements will improve the machinability without interfering with the physical properties of the alloy. The iron content is limited to 1 per cent.,* which probably is correct for the sand-casting alloy, although the gravity die-casting alloy could stand somewhat higher iron without losing any of the desirable qualities. Especially when a higher amount of manganese is present, the iron could be as high, probably, as 1.4 per cent.

TABLE VIII.—*Influence of Zn on the Strength of Heat-Treated Y Alloy.*

Zn, per cent.	Tensile strength, lbs. per sq. in.	Elongation, per cent.	Brinell hardness.	Heat treatment.
0	50 000	0.5	114	2
1.3 ..	59 000	0.5	125	2
0	47 500	1.5	110	A
0.7 ..	51 000	1.5	121	A
1.3 ..	52 000	1.5	127	A

These two alloys complete the study of a group of alloys in which copper is really the main alloying element. The copper content ranges from 10 per cent. down to 7, 4, and finally 2 per cent. The intentional additions to these alloys are silicon, nickel, and magnesium. All other alloying elements present in these alloys are considered as impurities, but even some of the main additions are considered impurities in many of the alloys. For example, the magnesium is generally considered as an undesirable impurity. Also the nickel is considered in most alloys as an undesirable impurity, and even silicon, in some of the alloys, is not desired. It should be stated that in copper alloys, silicon is always desirable since it increases the fluidity of the alloy and also reduces the hot shortness. The only alloy where silicon is not desired is the Y-alloy, in which the magnesium forms magnesium silicide, a powerful hardening compound. Magnesium is not desired in most of the alloys with the exception of the 10 per cent. copper alloy and Y-alloy. In the 10 per cent. copper alloy only small amounts such as 0.3 per cent. are necessary to cause sufficient hardening. In Y-alloy about 1.5 per cent. is specified to give

* Tests are conducted today to substitute 1 per cent. nickel in this alloy by 1 per cent. added iron, giving a total of 2-per cent. iron.

Effect of Minor Elements on Al Alloys

the desired properties. Nickel is very much desired when high strength at elevated temperature is required. It should be logical to suppose that this property is also desirable in other alloys, and a rigid limitation of nickel at percentages such as 0.1 or 0.3 per cent. should be avoided.

Manganese seems to be limited to 0.3 per cent. in most of the alloys for no apparent reason, and since it imparts very desirable properties to the aluminium alloys, it would be wise to increase the amount of manganese considerably, to get properties such as reduced hot shortness, reduced brittleness, higher strength at elevated temperatures, better machinability, and better dissemination of the iron compound in the alloy. Zinc, of course, is the element which has been most badly "maligned," and enough has been said in the previous paragraphs about zinc so that it does not need to be repeated here. The iron content depends largely on the mode of casting and, as stated above, it does not have to be as high in the pressure die casting as the specifications allow, while in some of the gravity die-casting alloys the content could be increased slightly without ill-effect. The other alloying elements such as lead, tin, bismuth, and antimony all improve the machinability of the alloys and seldom reach very high amounts, probably very seldom 1 per cent. total. They are neither hardening nor embrittling, can be controlled properly, and therefore are relatively harmless.

NON-METALLIC IMPURITIES

One subject has not been discussed in all these alloys, and that is the question of non-metallic impurities, such as oxides, nitrides, and the like. The statement is often made that remelt alloys contain more oxides than so-called high-purity alloys. It is unfortunate indeed that it is not possible to analyse for aluminium oxide and obtain reliable results which can be consistently reproduced. There is not one method which has been approved as dependable by any group of scientists. Therefore, it is easy for anyone to make the above statement. However, there is sound reasoning which can disprove it. Virgin aluminium, as it comes from the reduction cell, where it is born out of oxides, is loaded with oxides and fluxes to such an extent, that to make it usable it has to be remelted and cleaned of these impurities by fluxing, skimming, and holding in the furnace. Fluxing, skimming, and holding the metal are identical procedures in the production of virgin and remelt metal, and there is no basis for the assumption that these methods work any differently on virgin aluminium than on remelt aluminium.

When the above-mentioned refining methods are employed, it is possible to "purify" aluminium, even virgin, from non-metallics to such an extent that it becomes coarse crystalline, so that castings made from it are unsatisfactory, due to shrinkage. When, by the use of modifiers, oxides or other non-metallics are again introduced into aluminium alloys, the casting properties are improved and the metal exhibits superior properties to the super-purified metal. There is a definite similarity in other metals such as, for example, fine-grained steel.

It is, of course, possible to remelt aluminium and not remove the excess of non-metallics properly. This often happens when foundries reclaim their own scrap without adequate facilities and technique to condition the metal properly. This is most likely the reason why non-metallic impurities and remelt have become so closely associated in the minds of many. They do not realise that primary aluminium must be remelted to remove the non-metallics. This same reasoning must be brought forth when the gas content of these alloys is considered.

"Remelted" aluminium has been in competition with primary metal for many years, and when the composition of the remelted aluminium is comparable with that of primary, no difference in properties is found. That should be conclusive, both on the question of oxides and on any other prejudicial opinions regarding remelt aluminium.

SUMMARY

The discussion indicates that, with certain exceptions noted below, the effect of the minor alloying elements on the mechanical properties of aluminium-copper, aluminium-copper-silicon, and aluminium-copper-nickel alloys is either beneficial or innocuous. The only element which requires rigid control is magnesium. In all these alloys (with the exception of the 10 per cent. copper and the Y-alloy) 0.10 per cent. magnesium is the maximum which can be tolerated without causing loss in ductility. In cases where ductility is of prime importance, limitation of magnesium to 0.05 per cent. is indicated.

Iron is the next element which must be watched carefully. Since much of the contamination arises through the foundry process, every precaution should be taken to prevent unnecessary iron pickup. This is the more serious as the silicon content increases.

All the other elements such as manganese, titanium, nickel, chromium, and cobalt in one group; and tin, lead, antimony, bismuth, and cadmium in another group, are usually present in small enough amounts so that there is no harm; in fact, we pointed out, in many cases great advantages occur when they are present. Furthermore, with good laboratory control and proper technique, these elements can be balanced so that the maximum benefit is gained by their presence.

One fact should be stated; that in many cases the presence of the elements mentioned in the above discussion sometimes changes the casting characteristics – and some adjustments in the foundry practice may have to be made to suit the alloy. In many cases, the alloys have a somewhat lower melting point and greater fluidity; therefore, the pouring temperatures can be lowered.

There seems to be a question about what are the important physical properties on which the designer and engineer can rely. In most specifications only a minimum tensile strength and elongation are given which would imply that these two are the only properties which the engineer requires. In many alloys

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the elongation seems to be of prime importance. It is, however, certain that a casting stressed to an extent of considerably less than one-half of the required 6 per cent. minimum elongation could only be used where dimensional stability does not matter. A casting must be strong enough to resist deformation. The measure for resistance to the earliest stages of permanent deformation is the proportional limit and the yield strength and not the elongation and tensile strength found in a fractured test bar or casting. It appears reasonable to class an alloy having 7 tons per sq. in. proportional limit, 10.7 tons per sq. in. yield strength, 15.2 tons per sq. in. tensile strength, and only 4 per cent. elongation superior in regards to dimensional stability under stress to an alloy having only 4.5 tons per sq. in. proportional limit, 7 tons per sq. in. yield strength, 15.2 tons per sq. in. tensile strength, and 8 per cent. elongation. Differences of this order are commonly found between remelt aluminium alloys and primary alloys. Remelt alloys usually exhibit the greater proportional limit and yield strength and somewhat lower elongation. It therefore seems advisable to supply the designing engineers with data on proportional limit and yield strength in addition to the present information on tensile strength and elongation. If these data were made available for aluminium alloys, the question of composition would be simplified.

An excellent bibliography of 238 references, prepared by the author, Mr. D. Basch, Mr. J. G. G. Frost, and Mr. W. Rowe, is appended to the Paper.

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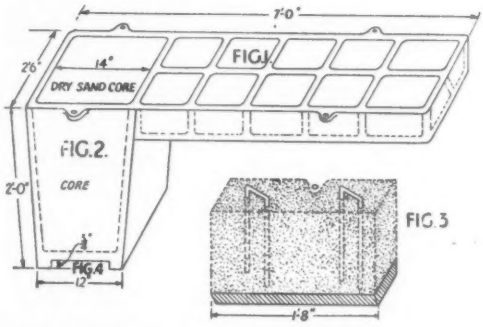
Effect of Cupola Slag on Cast-Iron Properties—In "Liteinoje Delo" (the Russian foundry journal), J. A. SMOLJANITSKI reports on the results of investigations on the effect of cupola slags on the structure and properties of cast iron. Various slags were examined, and it was found that a very beneficial action is exercised by adding a flux composed of dolomite and open-hearth slag. If lime alone is used, the graphite is very coarse and the iron has low strength values; much better values are obtained by the addition of open-hearth slag. There appears to be no connection between the composition and viscosity of the slags or between the viscosity of the slag and the mechanical properties of the iron. The slags do not appear to influence the metallic matrix of the cast iron. If low viscosity slags are used, the graphite is coarse and the strength of the iron very low.

WHY A DRAW-BACK WAS USED

By W.G.

An important part of the operations of moulding the bedplate shown in Fig. 1 is the one of setting the large dry sand core (Fig. 2). The reason for this is the narrowness and depth of this part of the pattern, which measures 2 ft. by 12 in., tapering out to 14 in. at the top. Such a design makes the operation of lowering and setting the core so as to secure equal thickness of metal on all four sides an uncertain one. With these considerations in mind it was decided to use a draw-back for the purpose of lifting away one side of the deep portion of the mould. The draw-back, rammed up on the lifting plate and parted (Fig. 3), is made 8 in. wider than the mould, thus giving a margin of 4 in. at each side of the joint. This liberal margin prevents the draw-back from being rammed in when it is replaced.

After the pattern is withdrawn, the rammed sand at the back of the plate is dug out and the whole



side is lifted away, leaving exposed the interior of the mould, which can now be finished with ease. It will be seen that there is ½ in. thickness of metal underneath the core (Fig. 4), which necessitates the placing of studs or the driving in of chaplets for the core to rest on. As the core is being lowered in the mould its progress downward can be guided and the thickness of metal at the sides be correctly assured. A final examination of the core and mould can then be taken before replacing the draw-back.

It is important to remember that the sand behind the draw-back must be solidly rammed, otherwise the metal will push it out of place, resulting in a waster. It cannot be denied, of course, that this job can be made without the use of a draw-back, but the extra time expended in making the plate and lifting it away from the mould is amply compensated for by the ease and certainty with which this part of the mould is finished.

SALVAGE ALL OLD BOOKS

BRAINS TRUST QUERIES—V

A further instalment of the report of the Foundry and Metallurgical Brains Trust of the London Branch of the Institute. Previous instalments appeared in our issues of July 30, August 17, September 17 and October 15.

Fluidity of Tropenas Steel

Question 11.—*Can the Brains Trust produce any evidence to prove that Tropenas steel is more fluid (has more life) than electric steel, providing composition and temperature are the same?* (From Mr. W. B. Lake, J.P., Braintree.)

MR. MURPHY said he understood from what he had seen in steel foundries, that Tropenas steel could be held longer than electric steel before pouring, and in that sense it preserved its life. If a mixed charge were introduced, the electric steel had to be used as soon as it was ready, whereas Tropenas steel could be kept waiting for pouring.

MR. KAIN disagreed with Mr. Murphy. The question, he said, was whether evidence could be produced to prove that Tropenas steel was more fluid than electric steel, providing composition and temperature were the same. It was presumed that the reference was to basic electric steel and not acid electric steel. There was a very general belief that converter steel was more fluid than electric steel, but he personally did not believe that that was so, provided that both steels were properly made. In discussions on the matter, many instances were quoted of non-fluid basic electric steel, but he had never heard anyone quote an instance of non-fluid converter steel. Non-fluid converter steels, however, were frequently made; an overblown converter steel was very sluggish and lacking in life, and had the characteristics of an over-oxidised electric steel. If an electric steel were grossly overoxidised and had to be kept under a reducing slag for any length of time, it lacked life; in his experience, an over-blown converter steel was equally lacking in life. Some years ago he had conducted experiments and kept records for several months in a foundry pouring converter and basic electric steel side by side with the same ladles, into similar moulds, and following the same pouring technique. The converter steel was consistently between 20 and 60 deg. C. hotter than the basic electric steel, as shown by readings obtained with an optical pyrometer by the same operator; also, the cooling rate of both steels was exactly the same, and when the cooling rates were plotted, the curves were exactly parallel. All the evidence was that converter steels were consistently hotter than basic electric steels to the extent of between 20 and 80 deg. C. In technical literature the idea of the greater fluidity of Tropenas steel over basic electric steel was gradually dying. In a Paper which would be published at the annual meeting of the Institute that very point would be discussed. (See JOURNAL, *July* 23, 1942.)

DR. DESCH said the question had been discussed very frequently when he was in Sheffield, and the belief then was that, if the two steels were tapped originally at the same temperature, the Tropenas steel retained its heat longer than the other steel. After a good deal of discussion the conclusion was arrived at that, there being more oxide in solution in the Tropenas steel, and as manganese was present also, and also the reaction between oxygen and manganese increased with falling temperature there was an exothermic reaction proceeding which maintained the temperature of the Tropenas steel. Temperature measurements, however, seemed to have altered that view. But the Sheffield foundries were carrying out development work in connection with the measurement of liquid temperatures, and as a result of it we should be able to make more exact measurements, instead of having to rely on the use of optical pyrometers, which needed correction.

MR. KAIN added that, in order to secure comparable results, both steels must be properly made under good metallurgical conditions.

Output Rating of Cupolas

Question 12.—*Is the output of a cupola,* i.e., *3 tons per hour, based on metal charged per hour or metal tapped per hour?* (From Mr. J. W. Gardom, Ripley.)

MR. LONGDEN said that surely the output must be the metal tapped per hour.

MR. KAIN pointed out that the cupola was a production machine and the foundryman was dependent on its output; surely that must be based on the metal tapped.

MR. MCRAE SMITH said it certainly seemed odd. After all, a cupola of 72-in. diameter could produce 15 or 20 tons per hour, according to conditions of working, but one might not charge it sufficiently to enable it to produce its maximum output. He could not see, therefore, how the output could be based on the amount of metal charged.

Nature of Gas Causing Casting Defects

Question 13.—*Improperly melted high-steel-content cast iron can give rise to casting defects due to the evolution of gas during solidification. What is the gas, and what is the mechanism of its absorption and rejection?* (From Mr. Chambers.)

DR. DESCH said it was not clear what was meant by the term "improperly melted." If one introduced very rusty scrap, or wet materials, and so on, then the gas evolved would be hydrogen and it would, of course, produce a very bad effect. But improper melting might be due to other causes than the absorption of hydrogen from water.

MR. CHAMBERS explained that he had experienced that particular type of defect only on one occasion, and he had purposely put his question rather vaguely because of his uncertainty as to just how the trouble arose. Certainly temperatures had nothing to do with it; the temperature was not too low. The first evidence of the trouble was the tendency to the rejection

Brains Trust Queries—V

of metal in the riser; there was an abnormal shrinkage and piping at the top of a heavy riser, and at the point of solidification there was a tendency for beads of metal to be forced back into the cavity of the riser. In the casting itself—and it was most evident in a heavy casting—machining might disclose intergranular cracks or, in a very bad case, cavities; those cavities were not so well defined as blowholes, but they were due to entrapped gases. The evidence in the riser showed that it occurred after solution, and at the moment of solidification. He could not give any further guidance as to the melting conditions which had given rise to the trouble, but very similar defects could be produced when using damp ladles. With rusty scrap in the cupola, the conditions could tend to the absorption of hydrogen.

DR. DESCH commented that some experiments had been in progress lately, not in connection with steel castings, but with ingots which were to be made into forgings, where the elimination of hydrogen was very important, because it gave rise to hair cracks. It had been found that contact with damp brickwork, or dampness in a spout or a ladle, would cause absorption of hydrogen, which was partly given off during freezing and partly after freezing. A great deal of hydrogen might be absorbed from a damp ladle or a damp spout.

MR. MCRAE SMITH said that perhaps he could answer the question partly, though not wholly. He believed Mr. Chambers meant that, when using a high-steel base charge, when the cupola contained a high percentage of steel scrap, such as 50 or 60 per cent., then under certain conditions the defect described could occur. It was always associated with low total-carbon content and a very short freezing range. At 3.5 per cent. total-carbon content it would not occur. But if the material had a total-carbon content of 2.8 or 2.7 per cent. or less, and if it were melted under certain conditions, the freezing range might be so reduced that the gases could not get away. It was very often associated in cupola melting, not only with rusty steel, but with very thin steel scrap; the steel scrap used in a cupola must have time to pick up carbon to a reasonable level before becoming completely melted. The temperature might be high, perhaps higher than the normal, but the solidification temperature would be very high, so that the freezing range was very short. One might find in the casting internal hot tears or cracks; they became particularly evident in heavy sections.

MR. MURPHY added that one possible source of hydrogen was steel which had been acid-pickled; such steel could absorb enormous quantities of hydrogen. That fact possibly had some bearing on Mr. McRae Smith's observation concerning the use of thin steel in the charge. He believed that most of that hydrogen could be removed by heating at fairly low temperature; but under cupola conditions it might not have the opportunity to get away.

(*Continued at foot of next column.*)

POST-WAR PLANNING

Sir William Jowitt, the Paymaster-General, is studying post-war reconstruction problems on behalf of the Government. It is suggested that a joint committee of representatives of the British Confederation of Employers, the Federation of British Industries, and the Trades Union Congress should be appointed to consult with the Minister. The proposal was before the General Council of the T.U.C. last week, when it was decided to approach the Minister in association with the Employers' Confederation and the F.B.I. The purpose is to bring the collective views of industrialists, both employers and workers, to bear on the Minister's inquiry before the shaping of policy begins in order that the Government may be fully informed of industrial opinion.

Sir George Schuster spoke on post-war planning when he addressed the Industrial Co-Partnership Association last week. The essentials of a new order in Britain, he said, included the reorganisation of industry with partnership between workers and management, the preservation of the liberty of individual enterprise, maximum productive efficiency, and some form of Government direction, and above all a new spirit of partnership. After the war there would be a demand for security of employment and for a more balanced economy.

PURCHASE OF MOBILE CRANES

As from January 1 the procedure for purchasing certain types of petrol or Diesel-driven mobile cranes will be altered, and all previous orders and authorisations made in respect of them will be cancelled, states the Ministry of Works. The types are mobile cranes on road wheels or crawler tracks and cranes mounted on road vehicles. Steam cranes and cranes on rail wheels will not be affected by these alterations, and the present procedure for obtaining them will remain in force. As from January 1 all persons intending to purchase mobile cranes must obtain an authorisation from the Joint Secretary, Engineer Stores Assignment Working Committee, Room 616, Lambeth Bridge House, London, S.E.1. This applies to all users of mobile cranes, irrespective of the purpose for which they are required. Application should be made to the Committee on Form X/ESA/MC/A, obtainable from the address stated. Authorisation to purchase will be made by the Committee, and the purchaser will be notified accordingly. No "M" form will be required, as the necessary allocation of steel will be made directly to the manufacturers by the Ministry of Supply.

(*Continued from previous column.*)

THE QUESTION-MASTER (Mr. R. B. Templeton) said the effect on the risers was the appearance of a huge cauliflower.

MR. CHAMBERS agreed that that was so in a very bad case.

(*To be continued.*)

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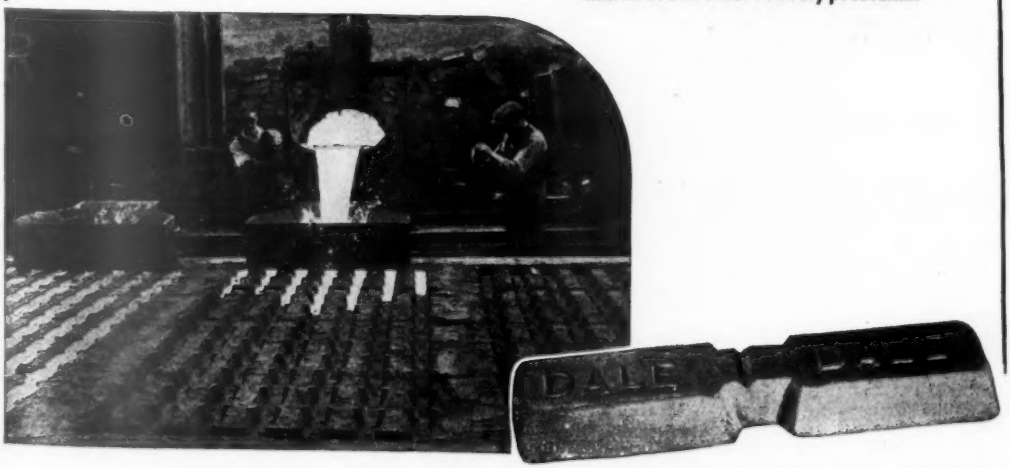

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NEWS IN BRIEF

WOMEN are to be admitted to membership of the Amalgamated Engineering Union from January 1 next.

WRIGHT'S CHILLED & GRAIN ROLL COMPANY, LIMITED, is being wound up voluntarily. Mr. F. H. A. Gittins, Priory Street, Dudley, is the liquidator.

THE FRIZINGTON IRON ORE COMPANY, LIMITED, is being wound up voluntarily. Mr. Charles Halliday, 11, Spring Gardens, Manchester, is the liquidator.

AT A MEETING of engineering firms in Wales at Cardiff recently it was decided to form a South Wales branch of the Engineering Industries Association.

THE NATIONAL HARDWARE ASSOCIATION has been renamed the National Steel and Hardware Association, to indicate the wider interests the Association now represents.

AN EXTRAORDINARY GENERAL MEETING of the stockholders of Ferranti, Limited, to be held to-day (Thursday) will be asked to pass a resolution increasing the company's borrowing powers.

THE BOARD OF TRADE have decided that, in respect of the period beginning December 3, 1942, and ending March 2, 1943, the rate of premium payable under any policy issued under the Commodity Insurance Scheme shall continue to be at the rate of 5s. per cent. per month.

AN ADVISORY COUNCIL representing all sides—employer, operative, and professional—of the building and civil engineering industries has been appointed by the Minister of Works and Planning. The council will examine and consider mutually problems and policies affecting the present and future position of these industries in relation to the country's requirements. The members of the council have been nominated by the federations and institutions concerned. Mr. G. H. Parker, representing the National Federation of Building Trades Employers, has been elected chairman.

ASSOCIATION OF BRONZE AND BRASS FOUNDERS

Since the publication of the original list of members in our issue of October 29, only five firms have not so far officially associated themselves with the new Association of Brass and Bronze Founders, while the following 25 concerns have since been elected:—Aluminium Bronze Company; Atlantis Foundry; Billington & Newton; Mr. C. Binks; T. M. Birkett; Barronia Metals; Bal-Nel Alloys; John Broadfoot & Sons; S. Dixon & Sons; Davies & Metcalfe; F. & C. Non-Ferrous Foundries; R. Harlow & Sons; Langley Alloys; Chas. S. Madan & Company; Marshall Osborne & Company; A. & R. Mason; Palatine Engineering Company; B. Rhodes & Son; Roberts Castings, Limited; Sandwell Casting Company; Sibleys (1922), Limited; Steven & Struthers; Wm. Wild & Sons; Edward Yates & Sons; and G.B.B. Foundry. Thus the membership has now reached 71, and is still growing.

PERSONAL

MR. G. A. R. MEAD has been appointed managing director of the Skefko Ball Bearing Company, Limited.

MR. P. S. TURNER has been appointed assistant managing director of Associated Electrical Industries, Limited.

MR. R. L. BROWN, managing director, has been appointed chairman of Hopkinsons, Limited, Huddersfield, in succession to Mr. Robert A. Hopkinson, who has retired from the board.

MR. HAROLD VERNON, a director of Thos. W. Ward, Limited, Sheffield, was appointed president of the British Association of Used Machine Tool Merchants at a luncheon in London on Friday, November 20, at which Sir Percy Mills, Controller-General of Machine Tools, was the chief guest.

NEWS HAS JUST been received that Mr. John S. Ferguson, of the Junior Technical School, Hong Kong, an associate member of the Scottish Branch of the Institute of British Foundrymen, was taken prisoner by the Japanese when the Colony fell last Christmas. At the time of his capture Mr. Ferguson was serving as a gunner with the Hong Kong Volunteer Defence Corps.

PROF. J. E. LENNARD-JONES, of Cambridge University, has been appointed by the Minister of Supply to be Chief Superintendent, Armament Research, and Mr. F. E. Smith, of Imperial Chemical Industries, Limited, has been appointed to the post of Chief Engineer and Superintendent, Armament Design. These appointments are a result of the recommendations of a committee under the chairmanship of Dr. H. L. Guy recently appointed by the Minister of Supply to review the machinery for the conduct of research, design, and experimental work in connection with the development of guns, small arms, and ammunition.

Wills

FELL, J. C., of Skipton, lead merchant	£15,643
HUGHES, W. E., of Sevenoaks, and Lime Street, London, E.C., metal merchant	£72,627
DURRAN, R. T., a director of the Skefko Ball Bearing Company, Limited, and other concerns	£91,522
ORCUTT, H. F. L., at one time general manager of the Birmingham Small Arms Company, Limited	£41,360
GREEN, D. W. R., of Brighton, chairman of Waygood-Otis, Limited, and Allen West & Company, Limited, and a director of the Rodney Foundry Company, Limited, and Greenland Securities, Limited	£40,015

NEW TRADE MARKS

The following applications to register trade marks appear in the "Trade Marks Journal":—

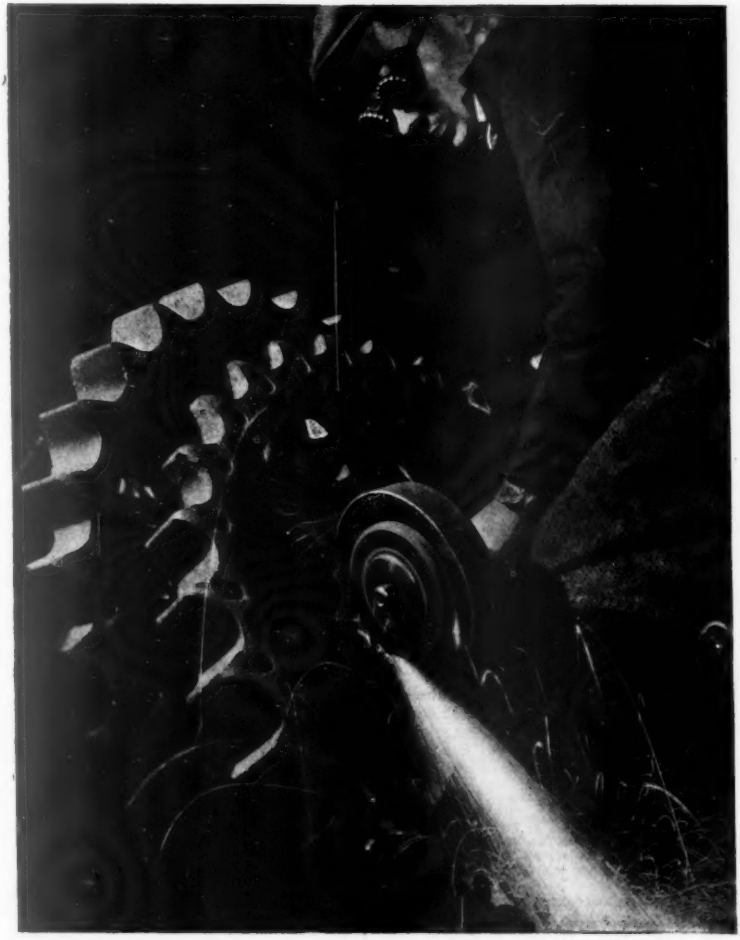
BELL DEVICE—Metal sinks. W. & G. SISSONS, LIMITED, 77, St. Marv's Road, Sheffield.

"LAGRESSA" — Abrasive products. LAVAPINE, LIMITED, 31, South Ward Road, Dundee.

"LIBATOOLS"—Machine tools. WINTOOLS, LIMITED, Audrey House, Ely Place, London, E.C.1.

"CASTLECUT"—Cutting steel. WATSON, SAVILLE & COMPANY, LIMITED, Mowbray Street, Sheffield, 3.

NORTON ABRASIVES



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OBTAINABLE FROM

NORTON GRINDING WHEEL CO. LTD.
WELWYN GARDEN CITY, HERTS.

OR

ALFRED HERBERT LTD.
COVENTRY

COMPANY NEWS

(Figures for previous year in brackets.)

Hepworth & Grandage—Dividend of 12½% (same).

F. H. Lloyd & Company—Interim dividend of 3%.

Whessoe Foundry & Engineering—Interim dividend of 10% (same).

Wellworthy Piston Rings—Final dividend of 10%, making 15% (same).

Power Gas Corporation—Dividend of 10%, plus a bonus of 2½% (same).

Allied Ironfounders—Interim dividend on the ordinary shares of 5% (2½%).

Whitehead Iron & Steel—Interim dividend on the ordinary stock of 10% (same).

Imperial Smelting—Dividend of 4% on the ordinary shares for the year to June 30 (same).

Tungsten Manufacturing—Net profit to September 30, 1941, £3,704 (loss £1,925); to tax reserve, £1,250; half-year's preference dividend to September 30, 1932, £1,139; credit forward, £921 (debit £395).

Walter Spencer & Company—Net profit to September 30, £12,536 (£12,107); dividend of 12½% (same); war damage insurance, £827 (£1,020); to reserve, £5,000 (same); forward (subject to tax settlement), £22,135 (£21,676).

Heenan & Froude—Net profit for the year ended August 31, before provision for taxation, £48,718 (£58,741); taxation, £30,000; dividend of 10% and a bonus of 5%, making 15% (same); to general reserve, £5,000; forward, £8,630 (£11,787).

British Piston Ring—Profit for the twelve months ended July 31, after providing for depreciation and taxation, £47,768; preference dividends, £4,000; ordinary dividend of 20% (same), £30,000; to general reserve, £10,000; forward, £36,520 (£32,752).

Wilkes—Net profit for the year to July 31, after providing for depreciation, £8,151 (£13,494); taxation, £4,017; to general reserve, £2,000; dividend on the preference shares, £546; dividend of 10% (same) on the ordinary shares, £1,250; forward, £3,266 (£2,929).

J. Brockhouse & Company—Net profit for the year ended September 30 last, after providing, in subsidiaries, taxation of £428,527 (£263,161), was £315,469 (£379,524); ordinary dividend of 20% (same); taxation reserve, £225,000 (£300,000); post-war reserve, £50,000 (nil); forward, £101,439 (£134,120).

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Westbury Engineering Company—£3,000. M. Dearden, H. Hargreaves, H. V. Dearden, and H. D. Crompton, Plant House, Holcombe. Bury, Lancs.

Tividale Foundry, 208, High Street, Watford, Herts—To take over the business carried on as the "Tividale Foundry & Engineering Company." £100. W. J. and A. Appleby and S. J. Roshier.

G. Valla & Son, 32A, The Mall, Ealing, London, W.5—Manufacturers of and dealers in machinery, parts and accessories, scientific instruments, etc. £2,000. G. and C. C. Valla, C. M. Grobecker, and R. J. Beaven.

OBITUARY

MR. GEORGE STANFIELD, a well-known Sheffield metallurgist, died recently. He had been associated with the Brown-Firth Research Laboratories for 26 years.

MR. WILLIAM EWING, who had been associated for many years with Chas. Connell & Company, Limited, engineers and shipbuilders, Scotstoun, died recently in Glasgow.

MR. W. THOMAS, of T. Rowlands & Company, Limited, iron and steel stockholders, Sheffield, died recently. Mr. Thomas had been connected with the company since its registration in the capacity of director and secretary.

MR. H. R. HUPTON, of Wolverhampton, has died in his 81st year. Mr. Hupton had carried on business as an iron and steel merchant in the town for nearly 50 years. He was a member of the Birmingham Exchange and Birmingham Chamber of Commerce, and was an original member of the National Federation of Scrap Iron, Steel and Metal Merchants.

MR. CHRISTOPHER WILSON, a director of the General Electric Company, Limited, died recently at the age of 73. Mr. Wilson joined the G.E.C. in 1888. He became manager of the engineering department and in 1895 he was transferred as joint general manager to the lamp works at Hammersmith, taking complete control of the works three years later. With the development of the lamp making organisation of the G.E.C., his control was extended to cover the company's kindred factories making glass and radio valves.

CLOTHES RATIONING IN INDUSTRY

The Board of Trade has informed the British Employers' Confederation that, in order to deal on the spot with some of the problems which arise at individual works under the clothes rationing scheme, the Board has appointed, as an experiment, six Industrial Clothing Officers, who will be available to visit employers when problems arise and to report the facts to the Board so that prompt action can be taken. All applications for visits from the Clothing Officers should at present be sent to the Board of Trade through the employers' organisations concerned and not direct by firms, and should be confined to cases which cannot be met by the normal methods of correspondence.

MACHINERY PARTS

The Board of Trade draws the attention of all users of machinery, plant and appliances controlled by the various Orders to the fact that repair parts can only be supplied without licence if they are required for the immediate and essential repair of machinery, etc., which is in current use. If an owner wishes to acquire parts for machinery which, because of concentration or for other reasons, is not in current use, he must obtain a licence before accepting the parts. Failure to do so is an offence under the Orders.

How much will **HEAT LOSSES** *claim*

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- **More Even Heat Distribution.**
- **Improved Control of Temperature.**

Efficient insulation can permit greater output — lower production costs — improved furnace control and better operating conditions.

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G.P.159

Raw Material Markets

IRON AND STEEL

One of the reasons for the slight improvement in activity at many light-castings establishments of late is the fact that more of these works are being closed down under the Government's concentration-of-industry plans; the remaining works are being called upon to cope with business previously placed with undertakings which have temporarily been shut down. Apart from the natural reluctance of many makers of light castings to close their doors there is also concern in this branch of industry as to the post-war effects of the present concentration scheme. It is felt in some districts, especially in Scotland, the home of the light foundry trade, that there may be attempts after the cessation of hostilities to establish the industry in other parts. In the middle of the eighteenth century Dr. Roebuck set up ironmaking facilities and from these the industry in the Falkirk and Bonnybridge districts has sprung up. Certain physical factors were responsible for the choice of location of the ironworks in the time of Dr. Roebuck, but these factors do not necessarily need to be considered any longer. Such fears as are held are probably groundless, though it would be as well that all manufacturing firms—foundries among them—keep in close touch with developments and study the import of all new trends, whether officially or unofficially inspired. Although the light foundry trade is not playing a major part in the war effort, it will come into its own after the war when building operations are set in motion.

There continues to be a large demand for all types of heavy castings and manufacturers are in possession of full order-books. While supplies of medium-phosphorus and refined irons and steel scrap are coming forward fairly satisfactorily, allocations of hematite and low-phosphorus irons are still strictly limited. High-phosphorus iron, on the other hand, which is used more by the light-castings industry, is readily available and many users have good stocks on hand.

There is little change in the foundry coke market; users generally have adequate reserve stocks and there are no reports of any interference with deliveries, not even by the small consumers who in many instances rely solely on week-to-week deliveries.

The steel industry continues to be exceedingly busy and holidays at Chrismastime for steelworks' employees are unlikely to be more than one day except in cases where it is necessary to carry out renovations, etc., when the opportunity of affording the workers a slightly longer holiday may be taken. There is a very large call for supplies of special and alloy qualities of steel and makers have developed their productive resources where possible, but still demand tends to outstrip the supply. Plates and sheets, etc., are fully absorbed by consumers associated with the war machine.

NON-FERROUS METALS

Not until after the war will it be possible to disclose statistical data relating to non-ferrous metals. It would be interesting at this juncture, not only to ourselves, but also to the enemy, to have complete figures of production, deliveries and consumption, but all that can be said is that the totals must be very high. A certain amount of the metal despatched fails to reach the United Kingdom, but in the case of copper, at any rate, the tonnage would seem to be of no great consequence, as all essential consumers appear to be receiving sufficient to enable them to operate on a full-time basis. Obviously the U-boat campaign is a menace which must still be reckoned with seriously—so much of our metal has to be imported that it would be foolish to do otherwise—but it is probable that the Control have stocks of copper on hand and the situation may be considered as being quite gratifying. Present conditions of warfare call for much larger quantities of the red metal than was the case in the last war. Production has, of course, expanded enormously since the 1914-18 conflict, but so also has consumption. The United Nations have their problems with regard to copper supplies, but what must the position of the Axis powers be seeing that their share of the world's output to-day is little in excess of 10 per cent.?

In the House of Commons recently, Mr. Douglas asked the Foreign Secretary whether the members of the committee under the agreement for international control of the production and export of tin had yet been appointed; upon what principles they were selected; and what producing interests they represented. Mr. Eden, in a written reply, said the delegations had been appointed by their respective governments under Article 10 of the agreement for the international control of the production and export of tin. He indicated that the British delegations representing Malaya and Nigeria are the same as those which represented those territories under the last agreement. They are in each case led by Sir John Campbell, a former Economic Adviser to the Colonial Office, and the interests of the Government and of the producers have both been borne in mind when determining the constitution of our delegations to this committee. The constitution of the new committee is as follows:—Belgian Congo: M. Theodore Heyse: Bolivia: H.E. Senor Don A. Patino, R. (voting member), Senor Don Juan Penaranda, Senor Jorge Ortiz Linares; Malaya: Sir John Campbell (voting member), Mr. V. A. Lowinger, Mr. W. J. Wilcoxson, Mr. J. H. Rich (adviser); Netherlands East Indies: Dr. G. H. C. Hart (voting member), Mr. P. H. Westermann (voting member in Dr. Hart's absence), Mr. J. B. Peyrot; Nigeria: Sir John Campbell (voting member), Mr. G. L. M. Clauson, Mr. Dermot J. Mooney, Mr. J. Ivan Spens (adviser).

Demand for spelter and lead for priority purposes is absorbing the bulk of the available supply. The Control are releasing fresh tonnages with the utmost discretion as a precautionary measure and it is good to note that all essential requirements are being met promptly.

Why "Phec"

is the peace-time plant for war-time use

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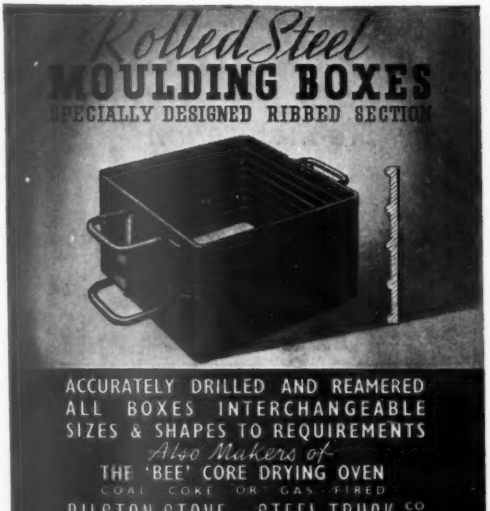

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Participating Associations : British Bath Manufacturers' Association ; British Ironfounders' Association ; British Malleable Tube Fittings Association; Cast Iron Axlebox Association ; Cast Iron Chair Association; Cast Iron Heating, Boiler and Radiator Manufacturers' Association; Cast Iron Segment Association ; Greensand Pipe Founders Association of Scotland; Ironfounders' National Confederation ; National Association of Malleable Ironfounders ; National Ingot Mould Association ; National Ironfounding Employers' Association; Agricultural Engineers' Association (affiliated) ; British Cast Iron Research Association (affiliated); British Grit Association (affiliated); Institute of British Foundrymen (affiliated).

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